ES ELECTRONIC SYSTEMS

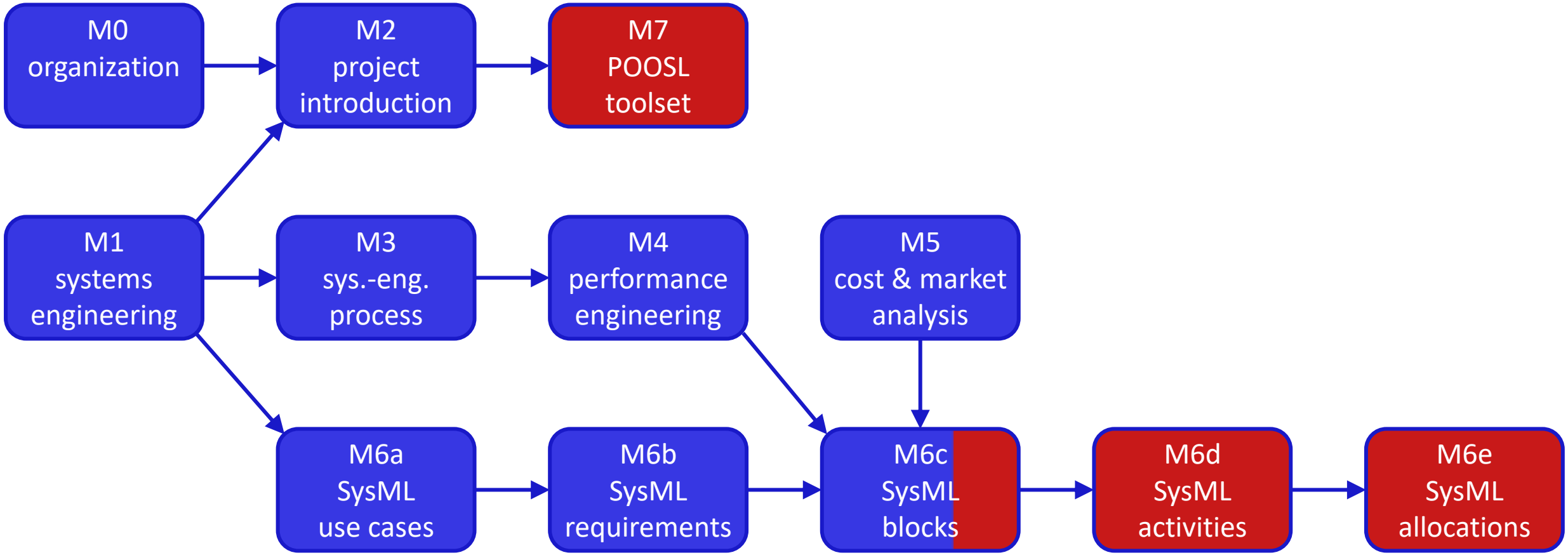
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

5XIC0 Electronic-Systems Engineering

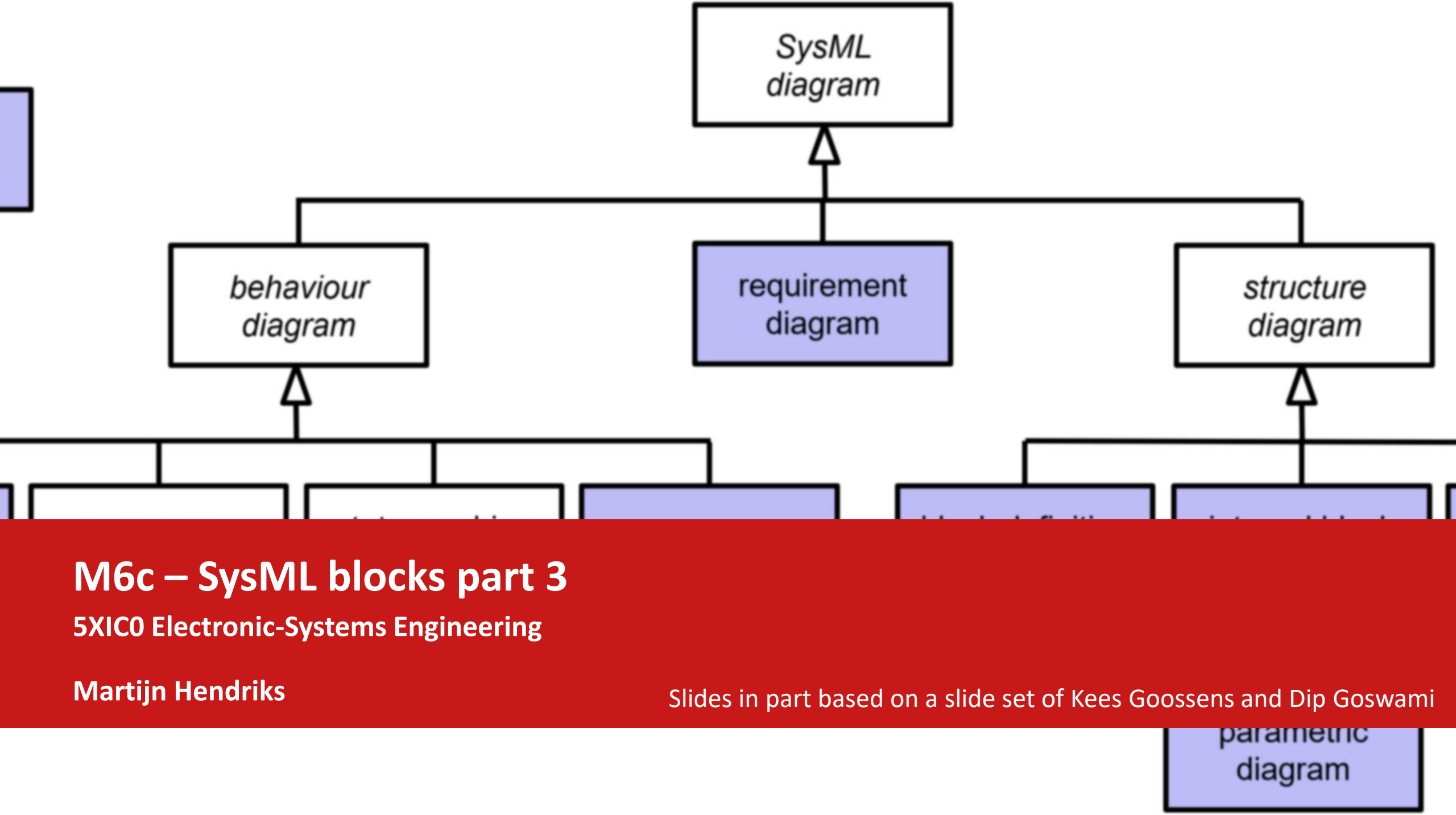
Twan Basten, Martijn Hendriks

Electrical Engineering

modules



ES ELECTRONIC SYSTEMS TU/e



M6c – SysML blocks part 3

5XIC0 Electronic-Systems Engineering

Martijn Hendriks

Slides in part based on a slide set of Kees Goossens and Dip Goswami

in this lecture

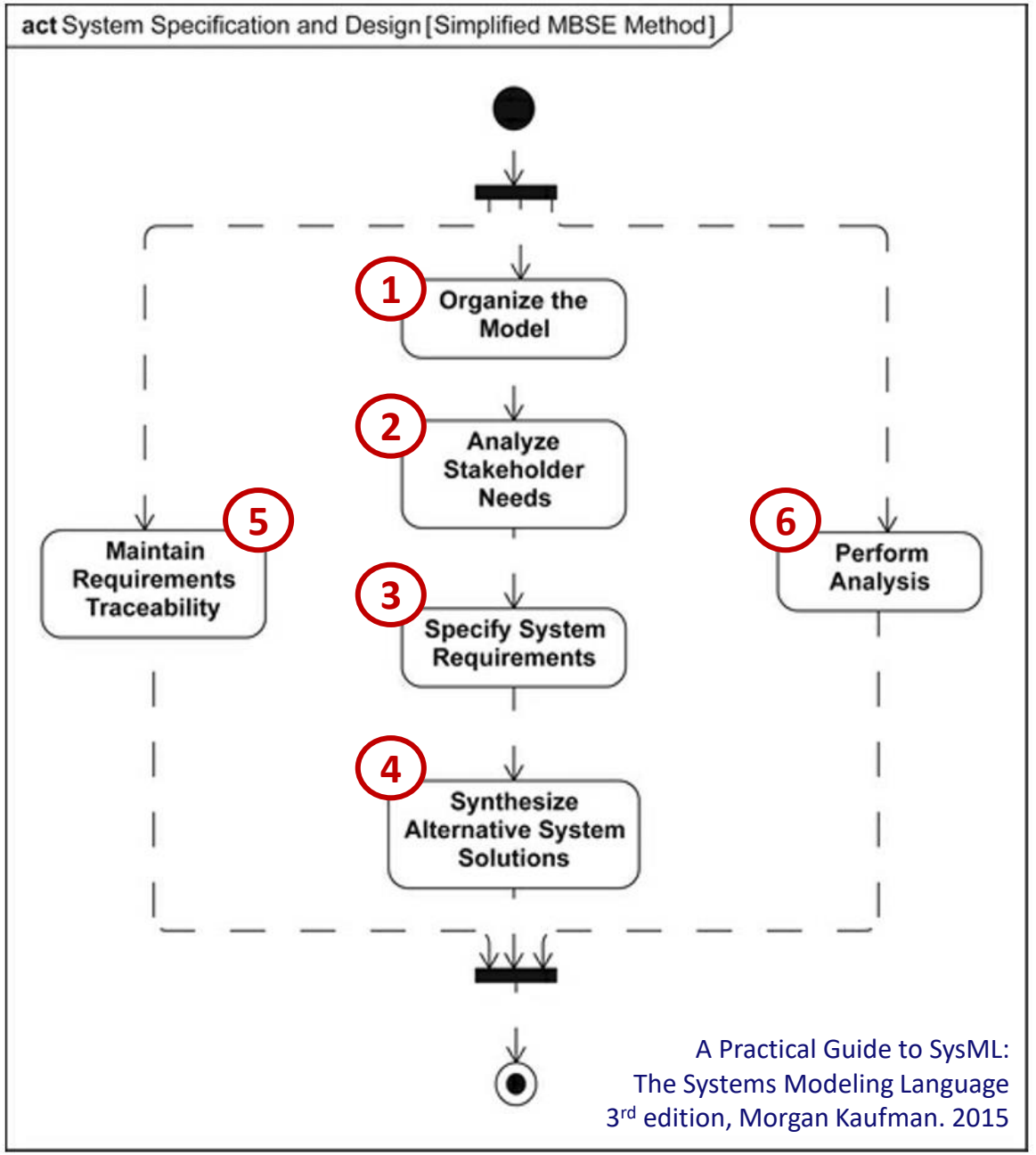
modeling design alternatives

modeling measures of effectiveness (moes)

- constraint blocks
- parameteric diagrams

a simplified² MBSE method

1. SysML package diagram
2. stakeholders
   SysML UC diagrams, UC descriptions
   measures of effectiveness (moes)
3. SysML requirement diagrams
4. **create multiple alternatives**
   - SysML BDDs – system decomposition
   - SysML IBDs – interconnections
   - SysML Activity diagrams – UC refinements
   - SysML Allocations – activities to blocks
5. requirements tracking
   - SysML Allocation – reqs to blocks/activities
6. - SysML PAR diagrams – covering all moes
   - POOSL models – makespan
   - analytical model – profit
   - verification



A Practical Guide to SysML:
The Systems Modeling Language
3rd edition, Morgan Kaufman. 2015

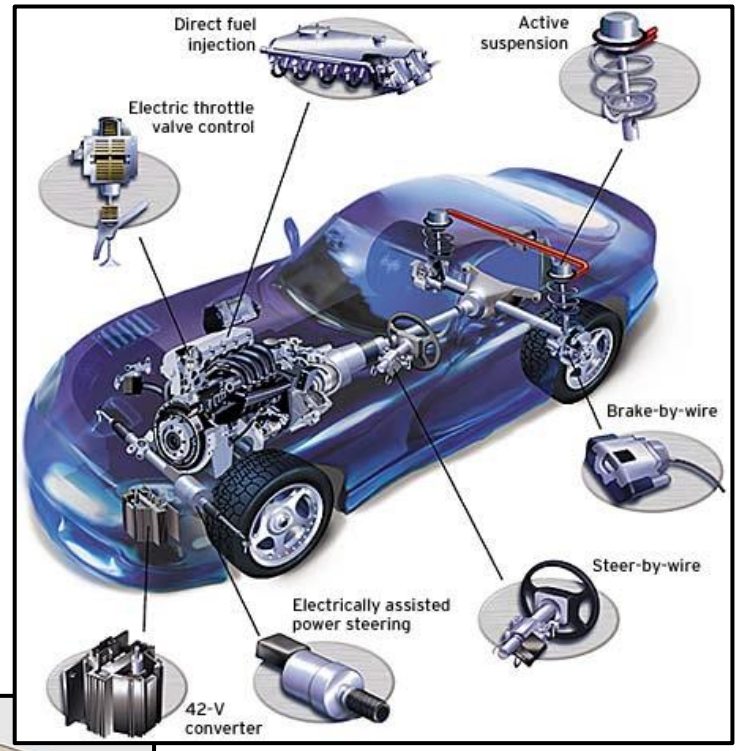
think – pair – share

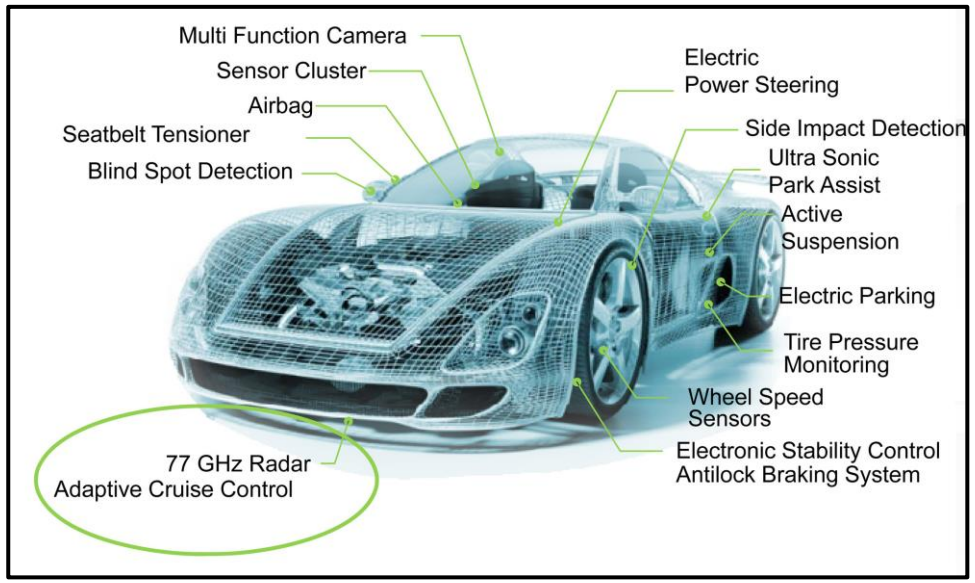
how to model structural design alternatives?

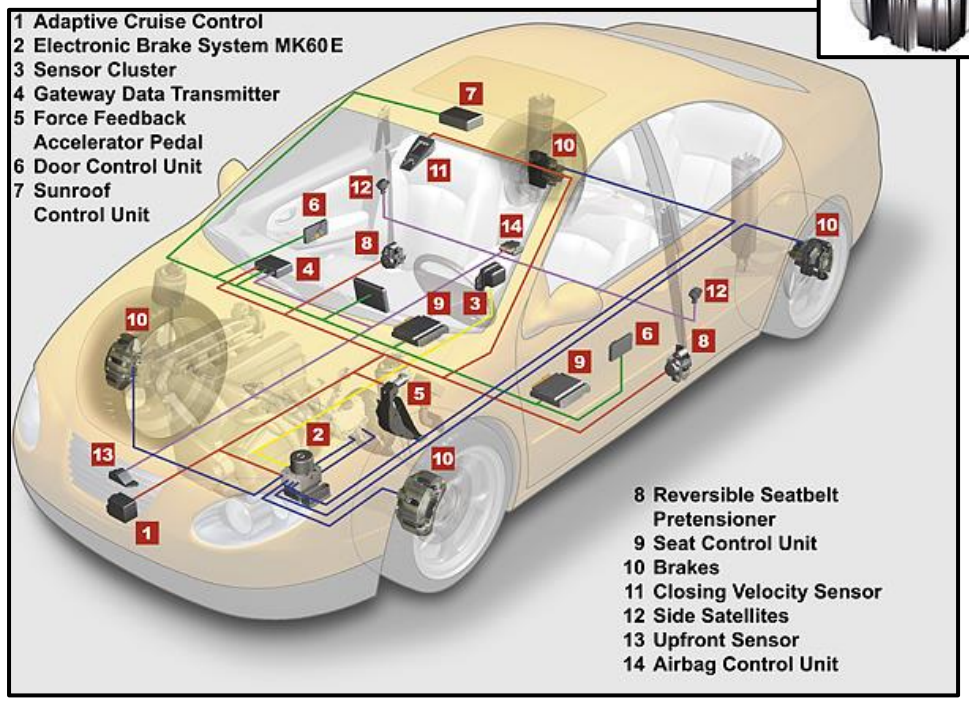
- specialization (BDDs)
  - add features
  - redefine features
    - restrict multiplicity
    - restrict type
    - add or change default value
- structural variation
  - composite or reference association (BDDs)
  - multiplicities (BDDs)
  - connections between parts (IBDs)

SysML – running example

A vehicle has a power train as one of its components. This power train can have a combustion engine, hybrid engine, or be fully electric. A hybrid power train has a single electric engine, and a fully electric one can have two or four (electric) engines. A combustion engine needs a fuel tank, and cars with an electric engine need a battery pack. Finally, we have 4 and 6-cylinder combustion engines.

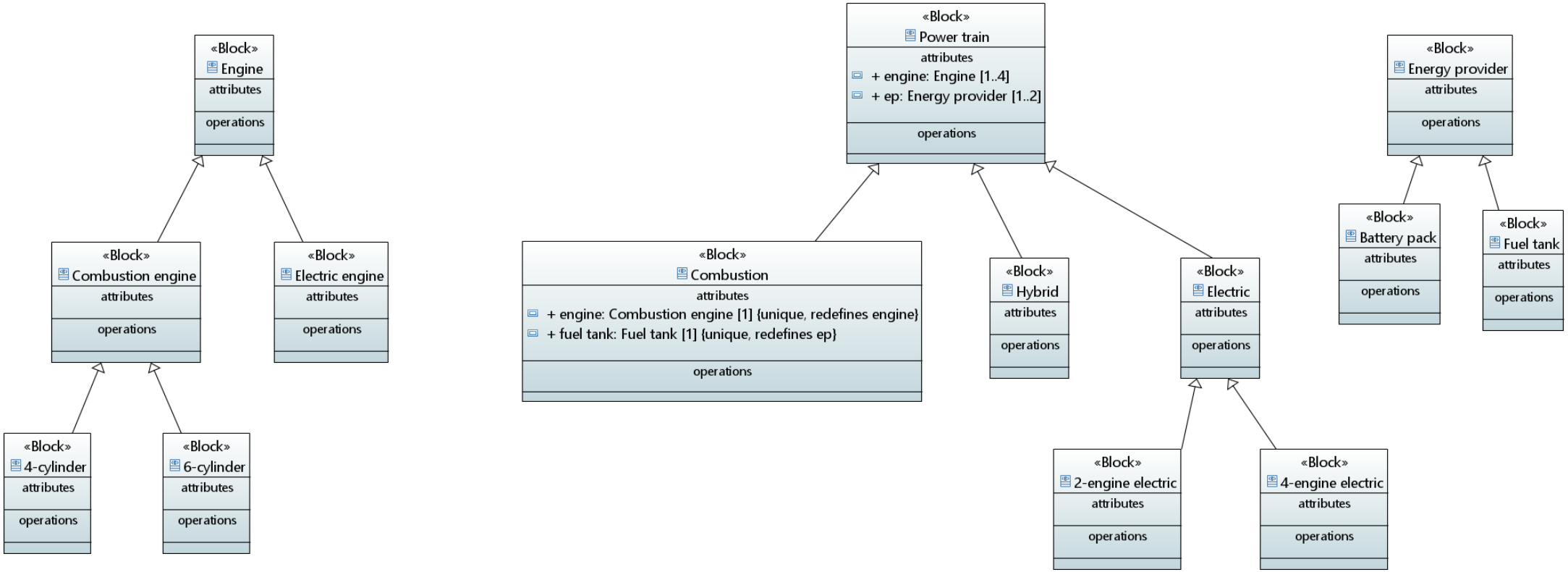






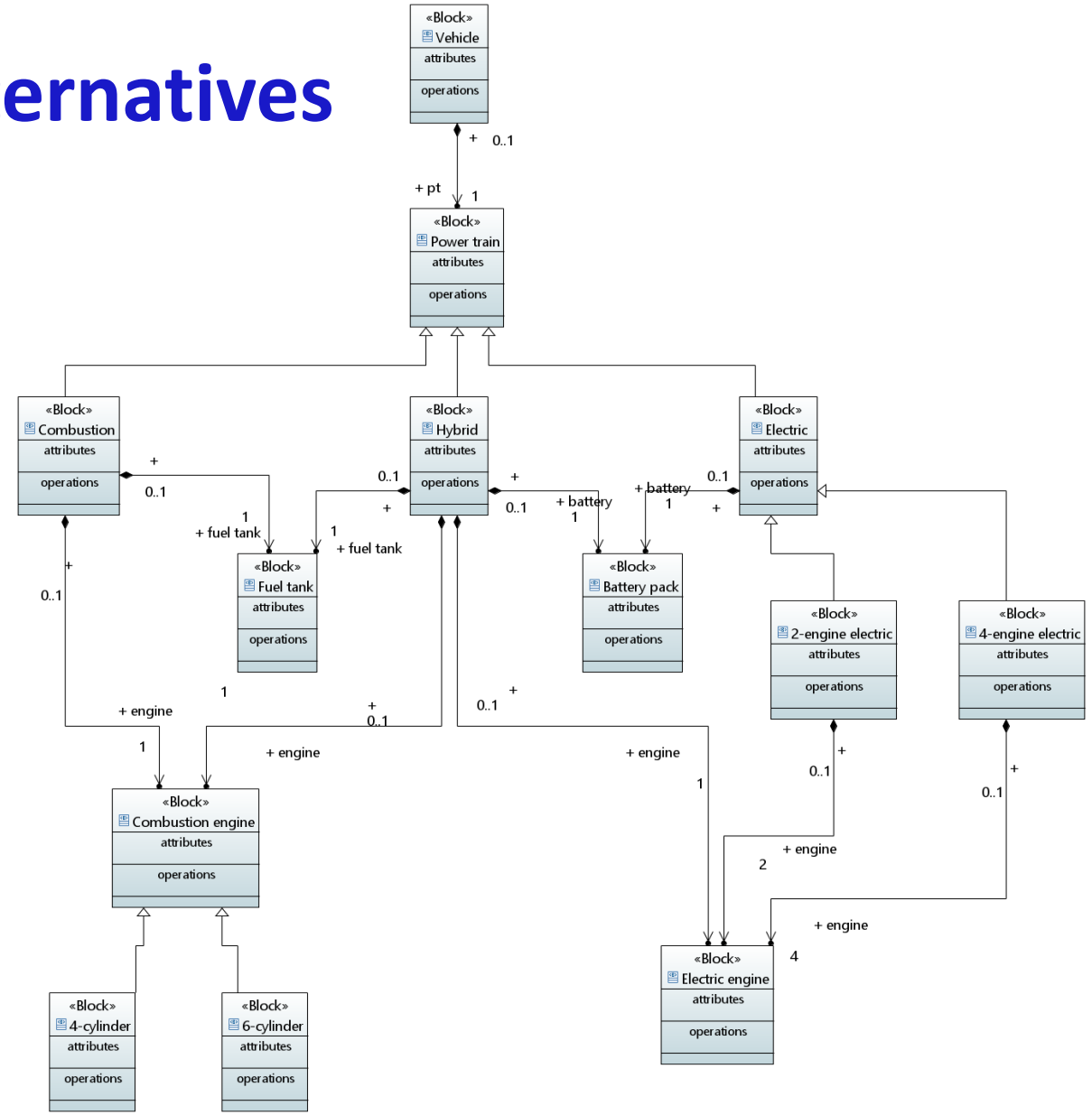
sources: motorola, aa1car.com

SysML – modeling design alternatives



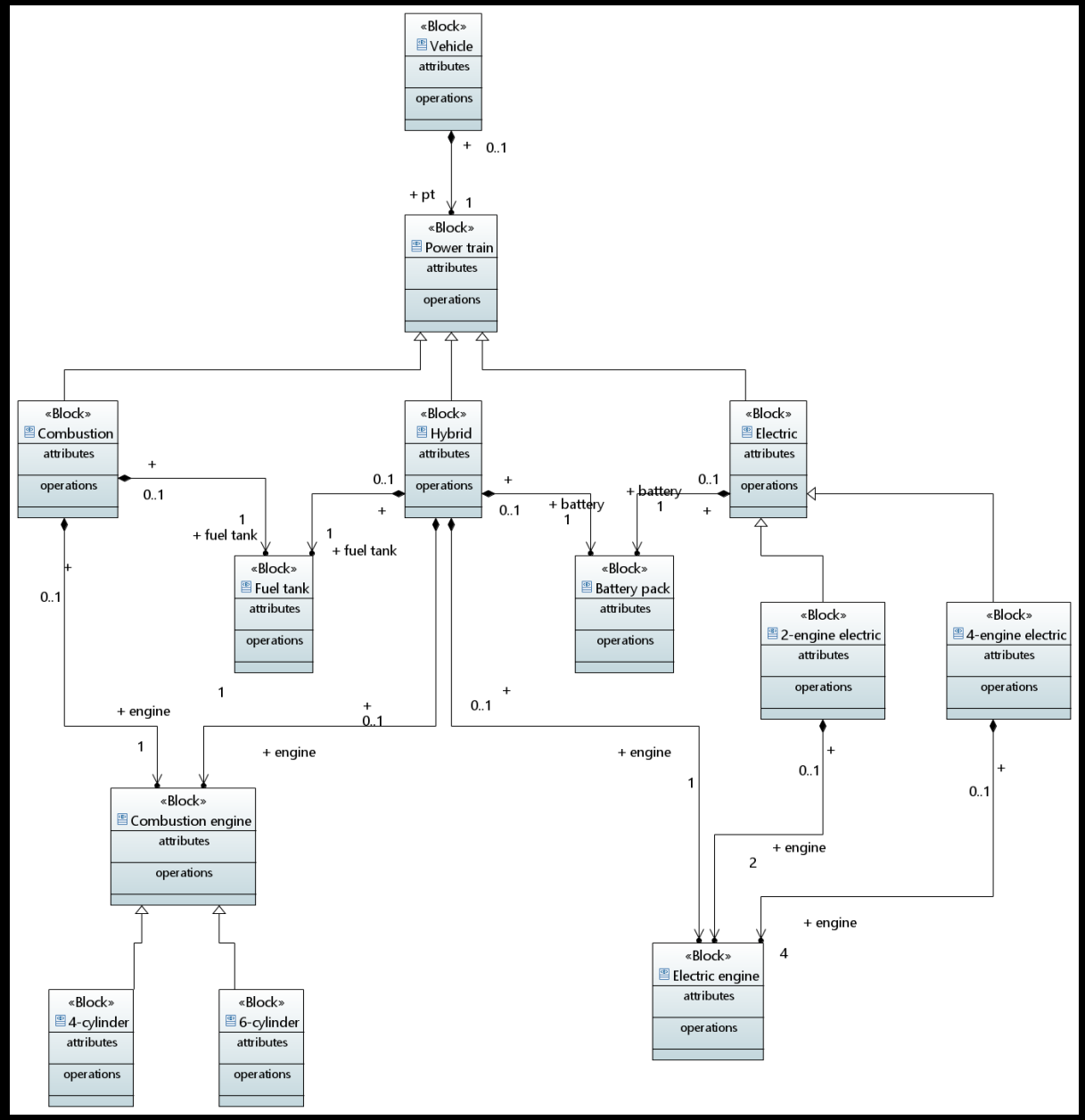
3 classification hierarchies

SysML – modeling design alternatives



think – pair – share

how many vehicle configurations are specified here



a simplified[2] MBSE method

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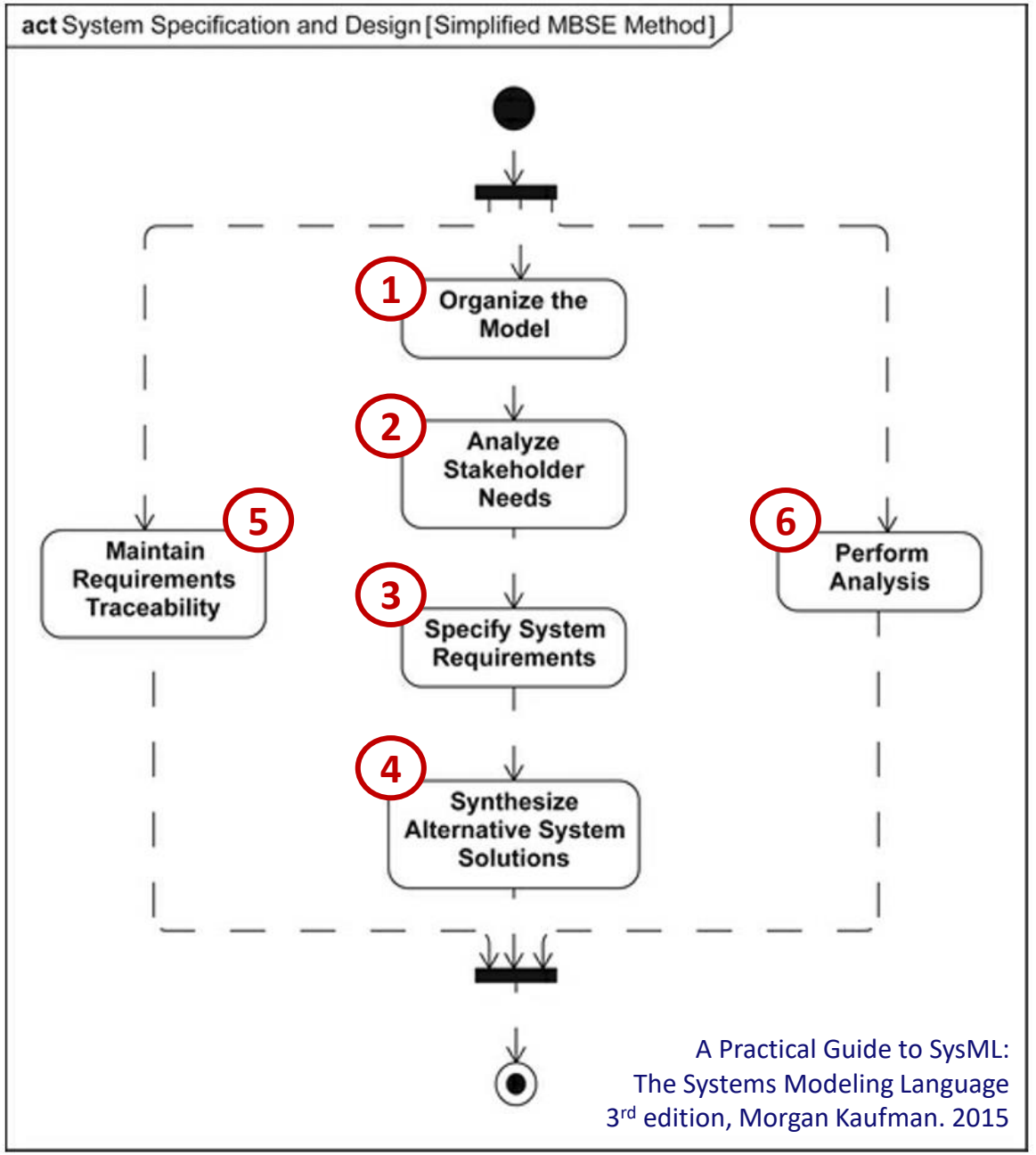

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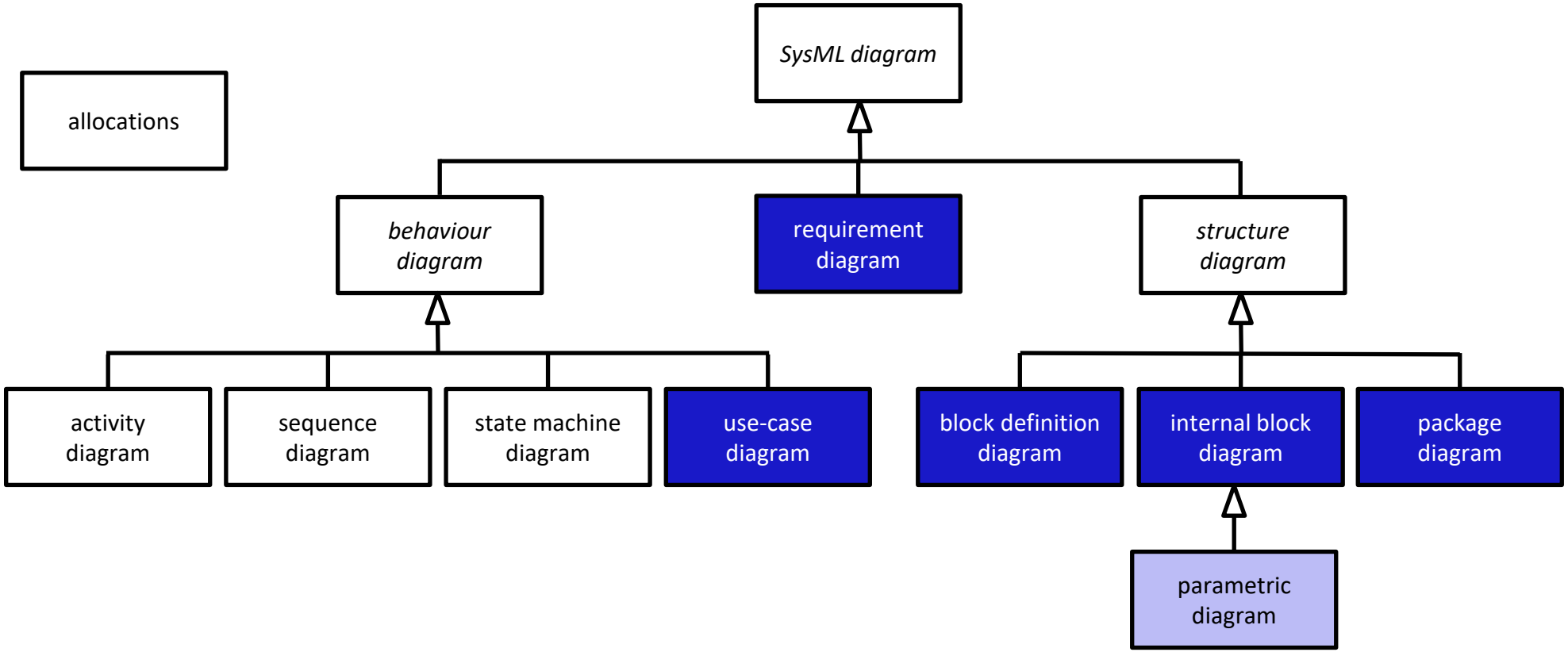
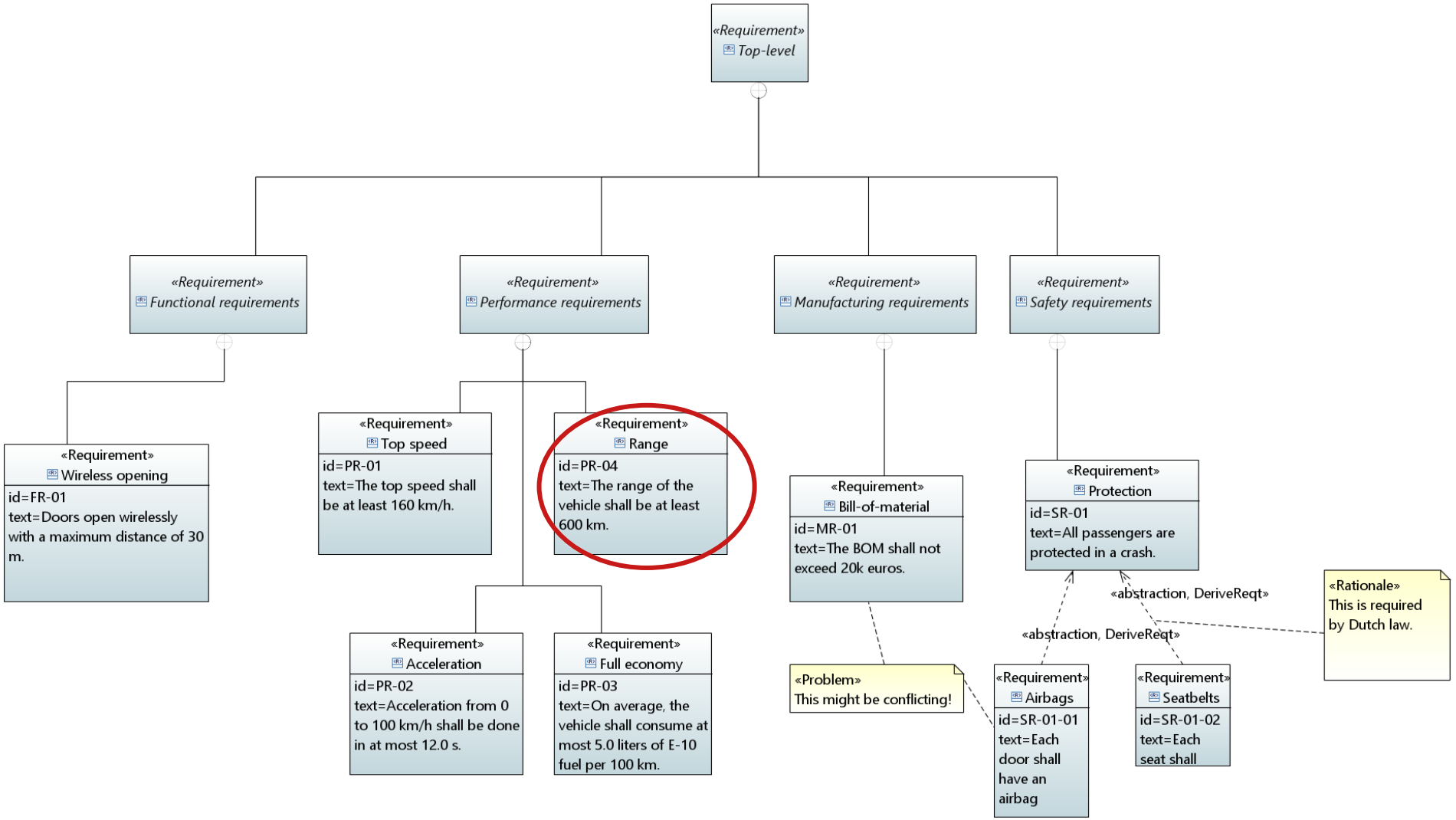
SysML – diagram overview

diagrams are **views** on the model
(i.e., on a subset of model elements)

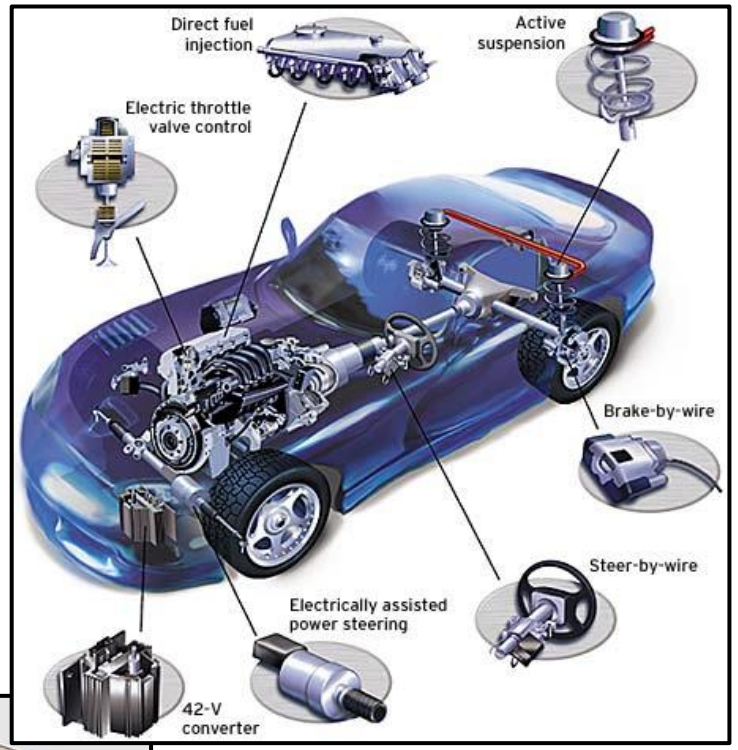


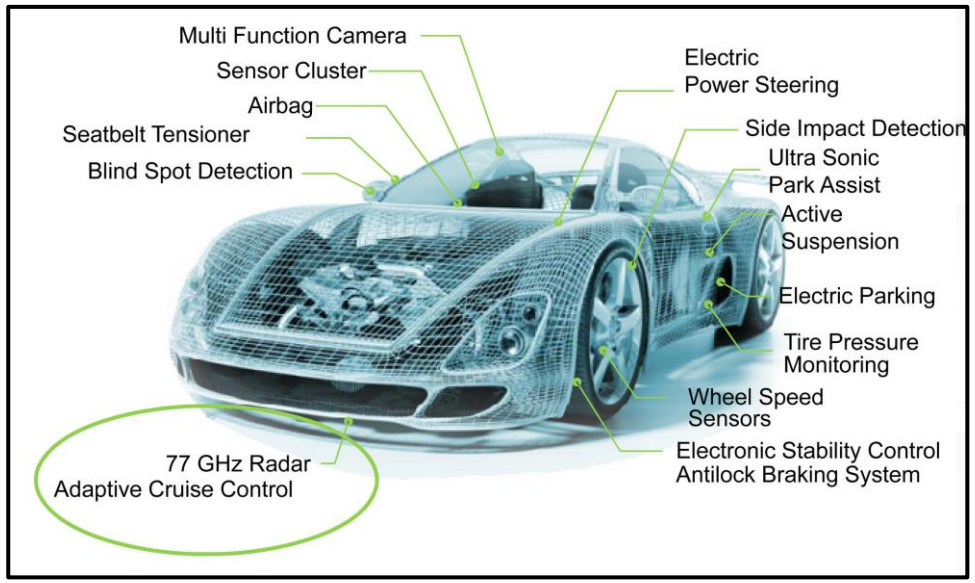
SysML – measures of effectiveness (moes)

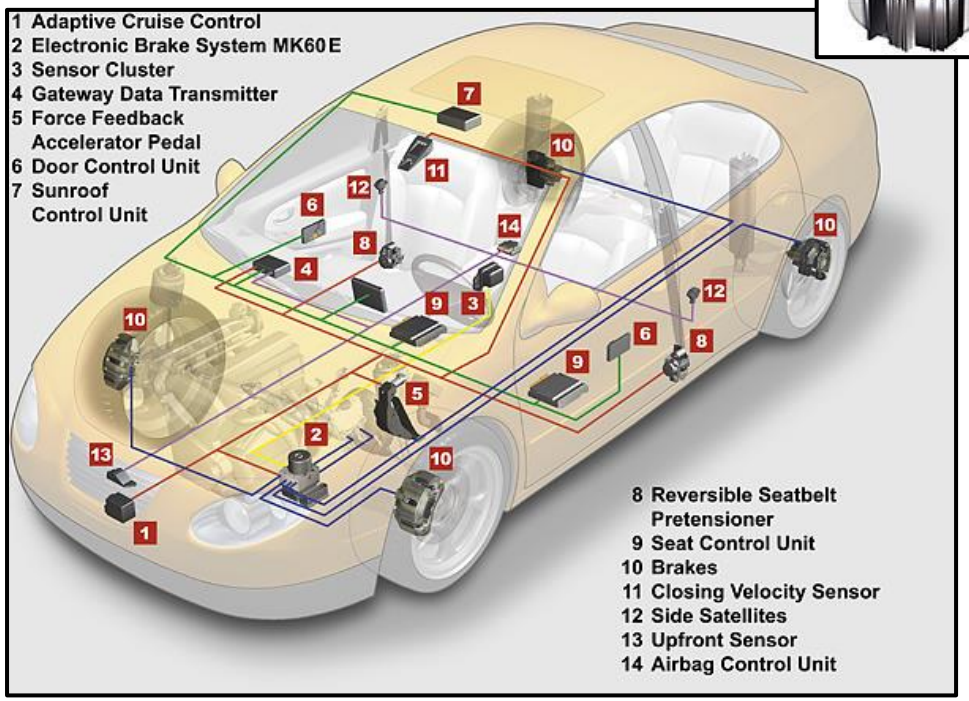


SysML – running example

Vehicle range depends on the average fuel consumption, and on the capacity of the fuel tank. Average fuel consumption is determined by the consumption in the city and by the consumption on the highway, and by the usage scenario (i.e., the ratio between city and highway usage).







sources: motorola, aa1car.com

think – pair – share

what are the two expressions that relate

- range
- fuelCapacity
- cityConsumption
- highwayConsumption
- ratio
- averageConsumption

Vehicle range depends on the average fuel consumption, and on the capacity of the fuel tank. Average fuel consumption is determined by the consumption in the city and by the consumption on the highway, and by the usage scenario (i.e., the ratio between city and highway usage).

avgCons = ratio * cityC + (1-ratio) * hwC

range = avgCons * fuelCapacity

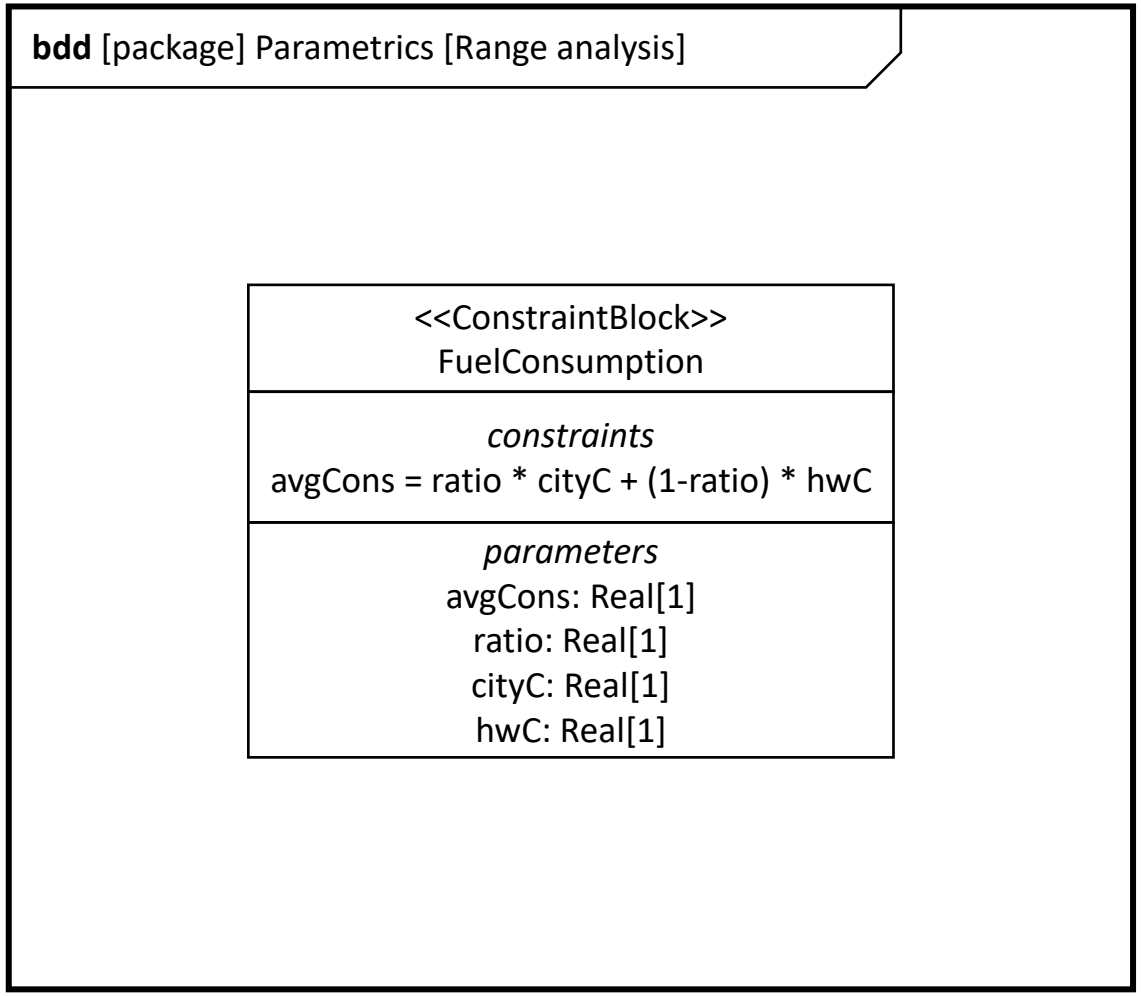
SysML – parametrics – model elements

constraint blocks

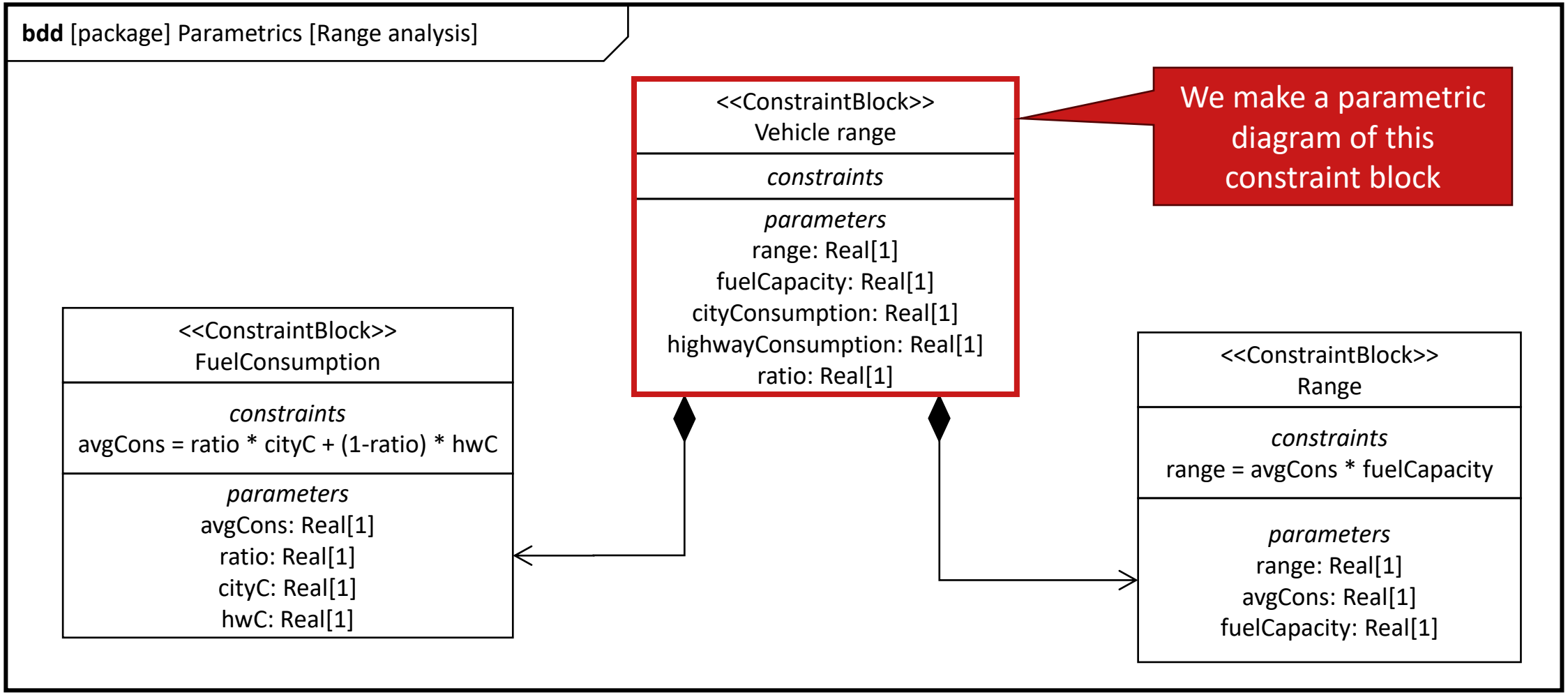
- constraint property (equivalent to a part)
  - expression as a text string using a domain-specific expression language (Java, C, MATLAB, …)
- constraint parameter
  - appears in a constraint property
  - can be bound to other parameters and to (value) properties of the block (binding connector)
  - typically, constraint parameters are value types

constraint blocks can be composed (e.g., on a bdd)

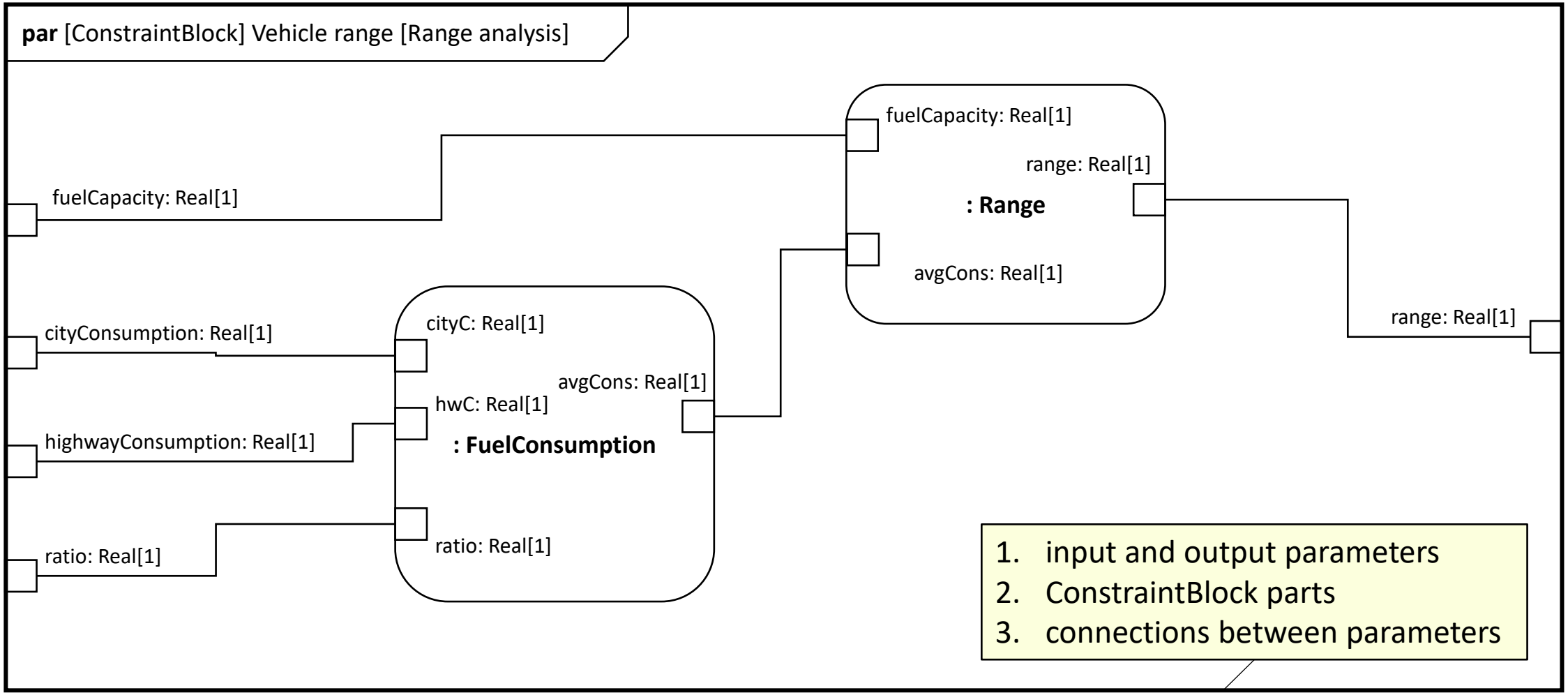
- use composite association to build more complex constraints



SysML – constraint modeling with a bdd



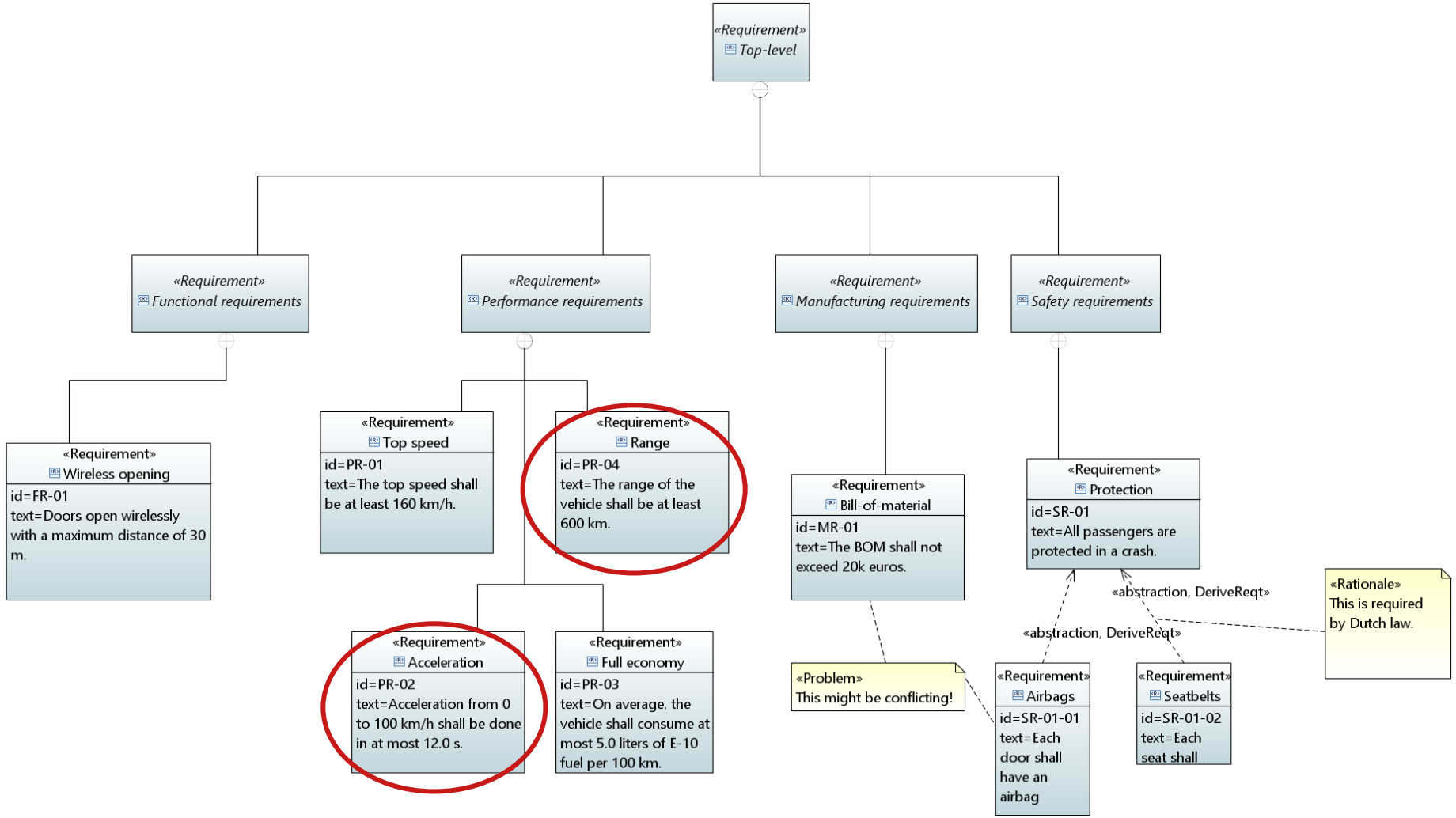
SysML – parametric diagram *(an IBD of a ConstraintBlock)*



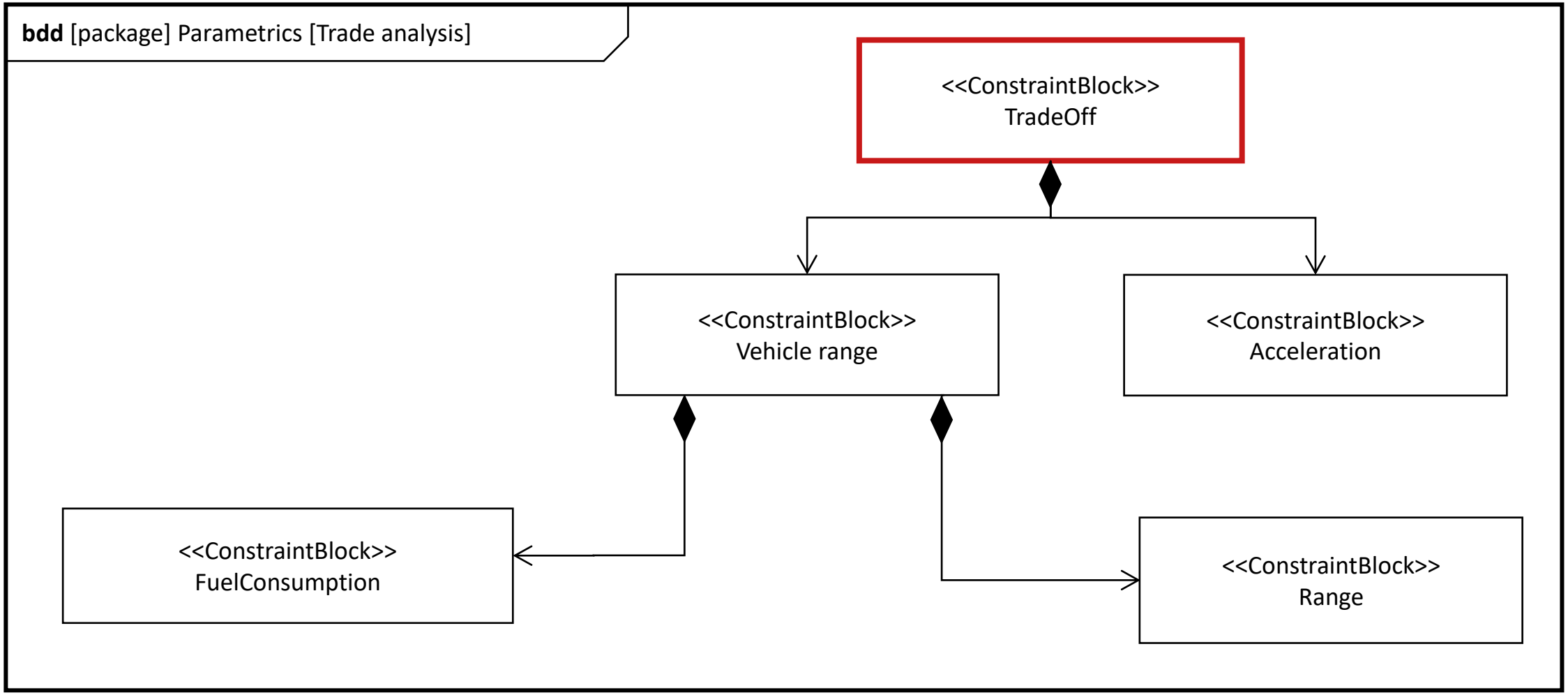
SysML – parametrics – recommended reading

Chapter 8, except 8.6 – 8.9

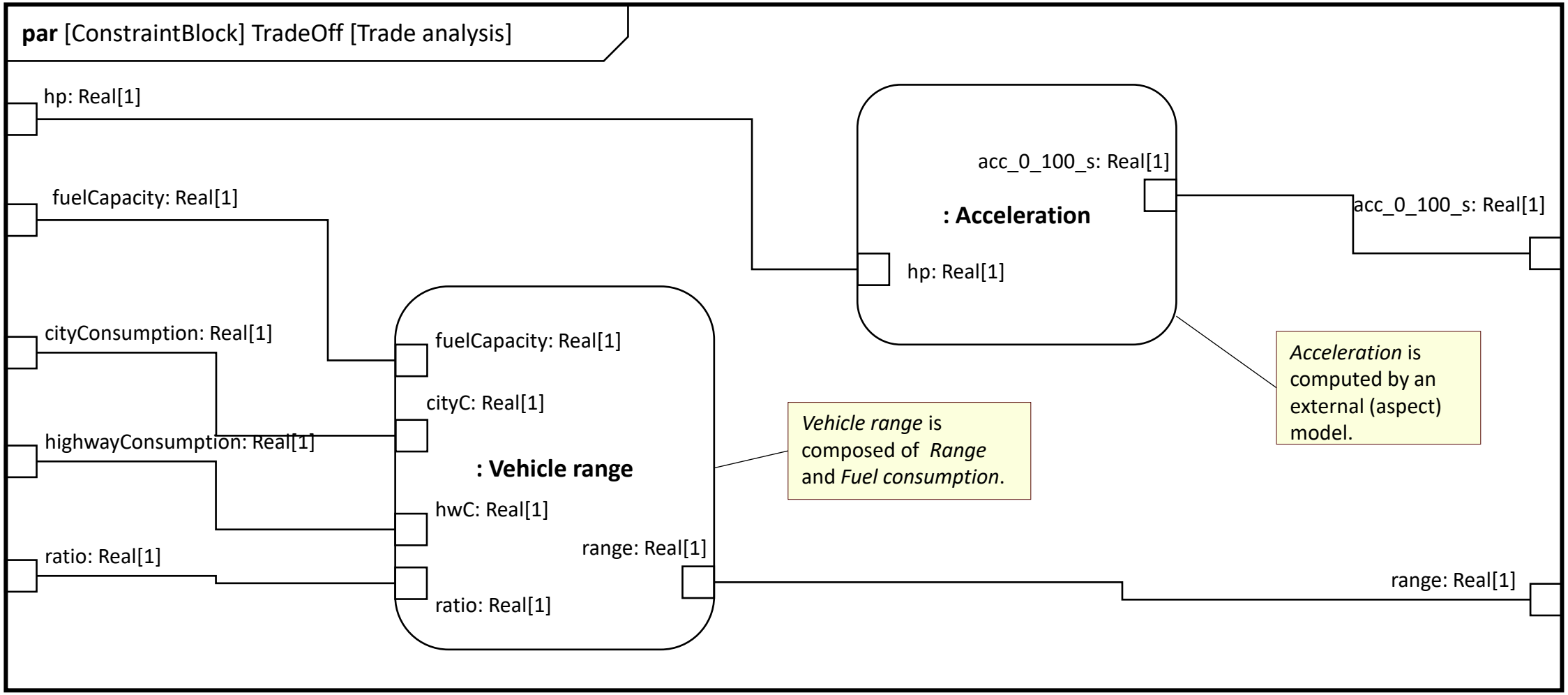
SysML – measures of effectiveness (moes)



SysML – constraint modeling with a bdd



SysML – parametric diagram for trade analysis



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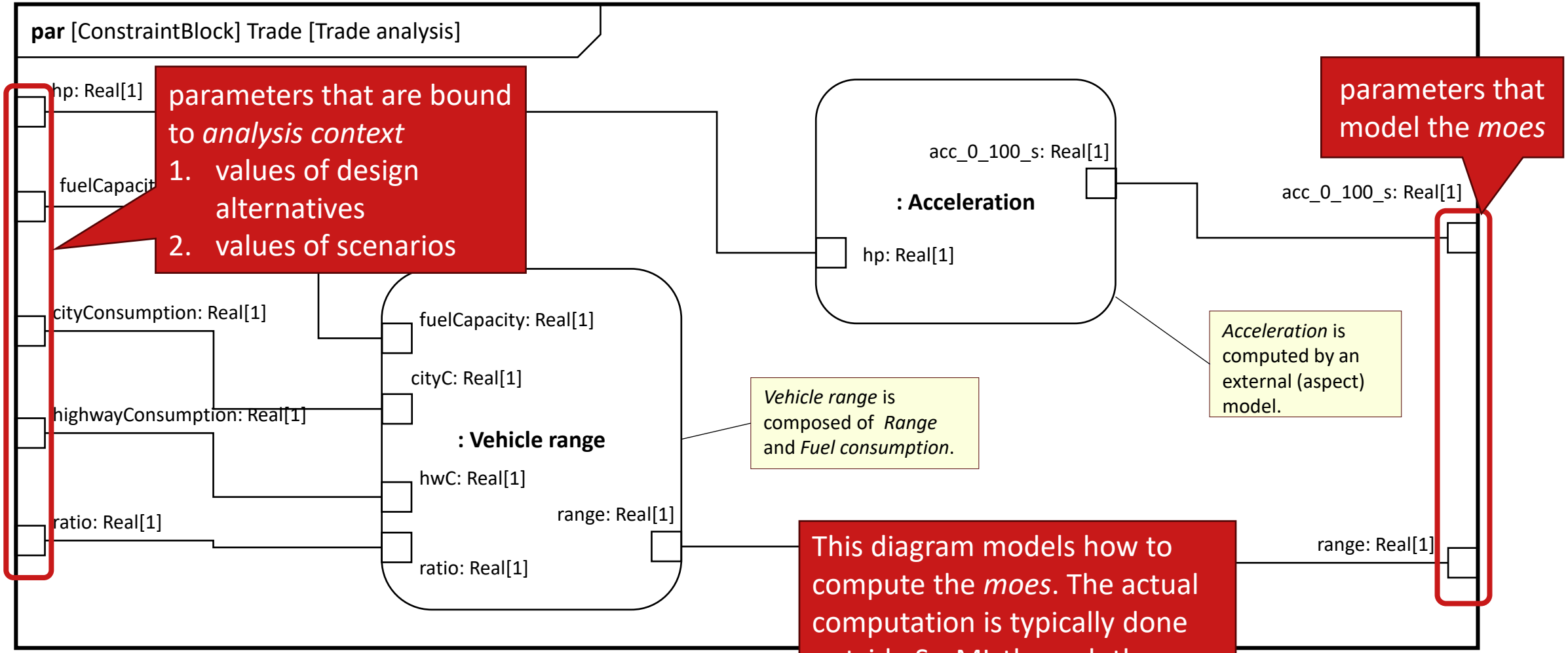
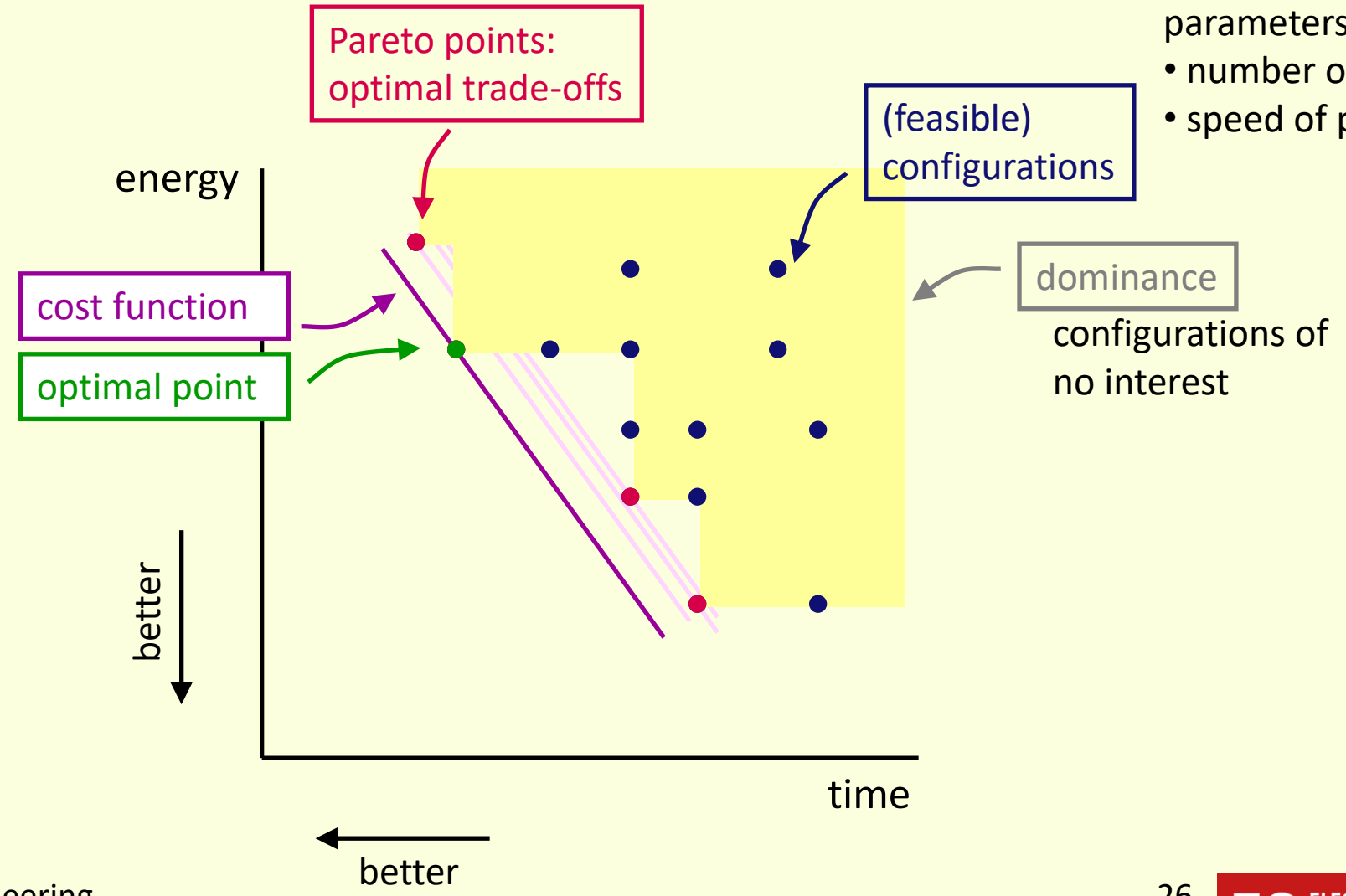


optimization - a Pareto space

multiple objectives,
e.g. **time** and **energy**



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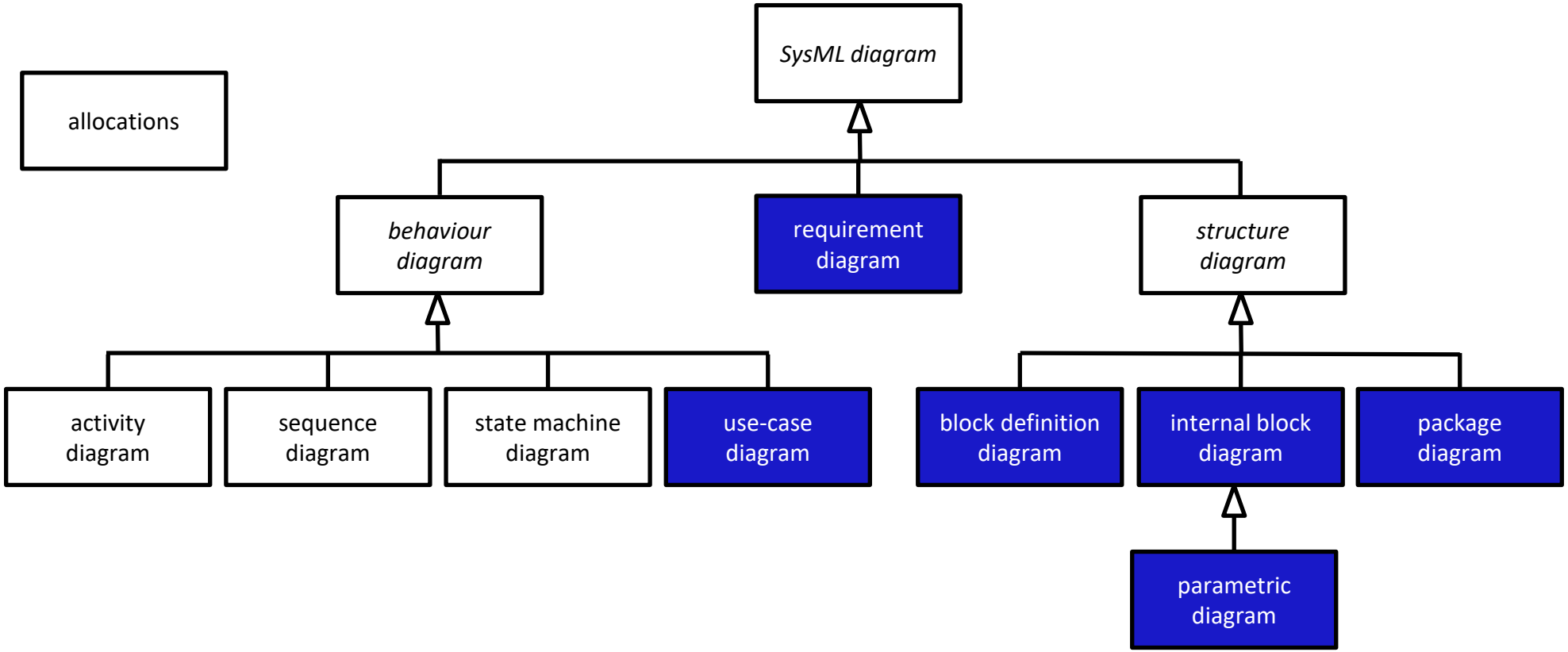
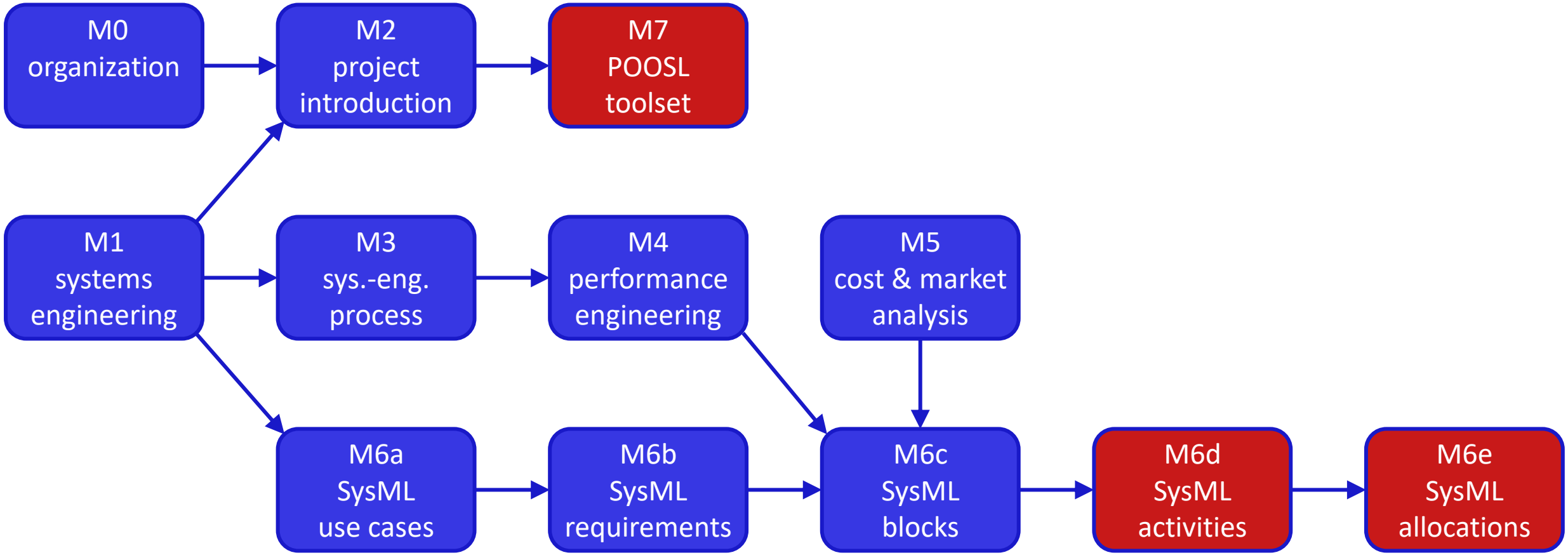


modules



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to remember

modeling of structural design alternatives

constraint blocks are special blocks with

- constraint properties
- constraint parameters

parametric diagram (special ibd) to specify the analysis of moes

- connects constraint properties

Papyrus model feedback

- deadline next Monday
- one model per group
- via Canvas; see instructions how to submit the model